

## Some Properties of Electric Circuits

*This version uses some lab equipment and CCK*

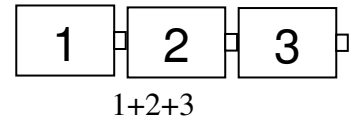
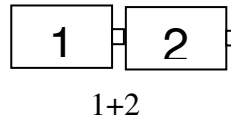
Learning Goals: Students will be able to

- Discuss basic electricity relationships
- Analyze the differences between real circuits and the simulated ones
- Build circuits from schematic drawings
- Use a multimeter to take readings in circuits.
- Provide reasoning to explain the measurements and relationships in circuits.

### I. Observing voltage relationships

Label three batteries 1, 2 and 3 with masking tape. Measure the voltage of each separately and record the real voltage in a table like the one shown. Then hold the batteries end to end as below to measure voltage for combinations.

Battery	Voltage (V) Real	Voltage (V) Simulation
1		
2		
3		
1+2		
1+2+3		



- Describe the relationship between the number of batteries and the voltage and explain what you think might be happening.
- Go to the PHeT web site and use the Circuit Construction Kit simulation (CCK) to do the same procedure. How does the real world data differ from the simulation? Explain what might cause the differences.
- Using CCK, what could you vary to test your description about the relationship between the number of batteries and the voltage? (Right click on the batteries to change characteristics ) Run several tests, recording your data in an organized table.
- Talk to another group about their description, tests and results. Rewrite your description to include the more broad tests.
- What do you see as the benefits of using the simulation?

### II. Using voltage

Use the Circuit Construction Kit simulation to build a circuit with a battery and a light bulb in the *Lifelike* visual mode

- Draw what your circuit looks like.
- How does the voltage of the battery compare to the light bulb voltage? Explain what you think is happening.
- Vary the voltage of the battery and write observations about how the brightness is affected by voltage.
- Think about a real light bulb and battery; explain what you think is happening that causes the changes in brightness.

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### III. Using voltage in series circuits

Use CCK to build the circuits below with a battery at about 12 volts and light bulbs. Turn on the voltmeter and ammeter to measure voltage of the battery and current into it. Record bulb brightness with descriptive language.

Figure 1

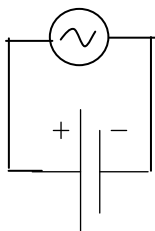


Figure 2

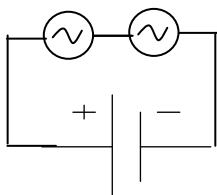
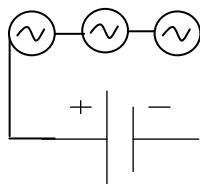


Figure 3



# of bulbs	Battery voltage (v)	Current into battery (A)	Brightness of bulbs
1			
2			
3			

- Summarize the relationships you observed and explain what you think is happening.
- Test to see if changing the battery voltage causes you to modify any of your conclusions. Explain what you measured and any conclusions you draw from your tests.
- What happens when you take a wire out of a circuit? Explain what you think is happening
- Practice using the voltmeter and realistic ammeter in several circuits. Describe how using a voltmeter is different from using an ammeter.

### IV. Using voltage in parallel circuits

Redo Part III but use figures 4-6 for the circuits. Make a new table and answer the questions.

Figure 4

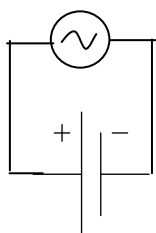


Figure 5

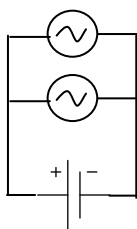
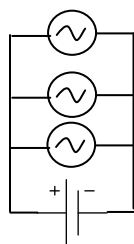


Figure 6

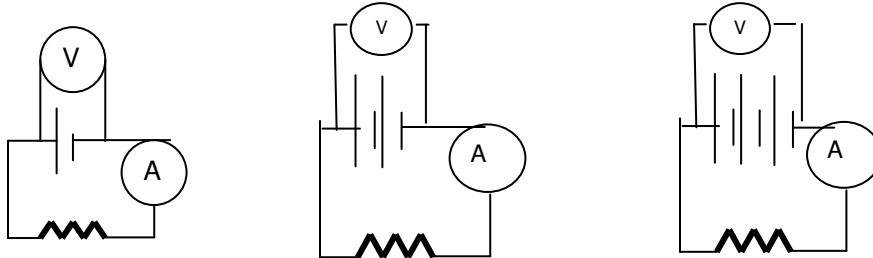


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### V. Observing voltage and current relationships with resistors

Get a real resistor that is less than  $100\Omega$ . Connect the following circuits without the meters. Then use one multimeter to get your readings by changing the mode and moving it. Record your data in a table like the one below.

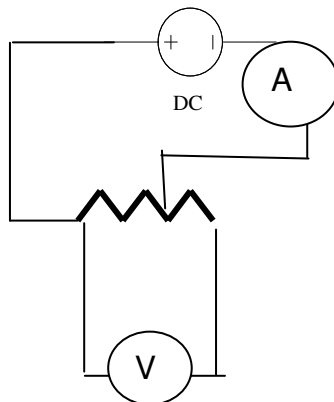


Number of batteries	Voltage (V)	Current (A)
1		
2		
3		

- Explain what might be happening to cause the change in current.
- How are current and battery voltage related? What would be the shape of the graph?
- Describe how you could use the simulation to verify the relationship. Test your ideas and make modifications to your original answers if necessary. Be sure to explain your reasoning.

### VI. Observing voltage and current relationships for variable resistors.

Use a real variable resistor connected to a power supply set on about 3 volts to make a circuit. Then use a multimeter to read the current and voltage where indicated. Vary the length of the resistor by moving the slider. Make a data table using with at least 10 lengths.



- Chart and determine the algebraic relationship with  $r^2$  for length and current.
- Chart and determine the algebraic relationship with  $r^2$  for length and voltage
- Describe what you think is happening within the circuit to make sense of the relationships. This experiment is similar to the one where you used CCK and varied the number of light bulbs. (*Remember light bulbs are just glowing resistors*).
- Write an error analysis in terms of precision and explain what you think could cause the variations.